Lake Sammamish Water Quality Response (Phosphorus) to Land Use Change

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King County

https://upload.wikimedia.org/wikipedia/commons/7/78/Aerial_Lake_Sammamish_Novemb

Lake Sammamish

Sixth largest lake in Washington

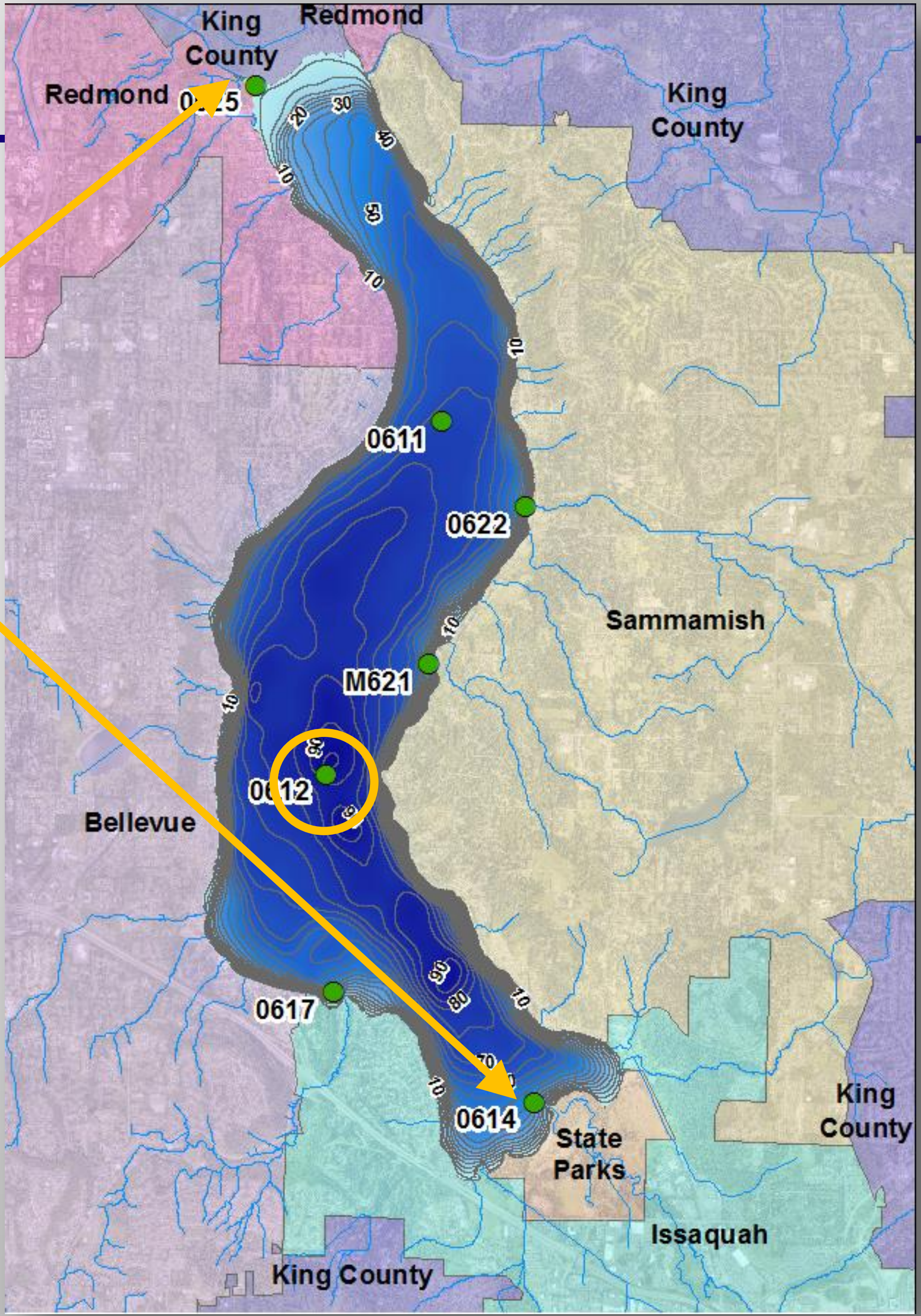
Outlet – Sammamish River
Major inlet – Issaquah Creek

Long-term monitoring station – 0612

1964-66 METRO

1970-75 University of WA

1981-2011 METRO/King County

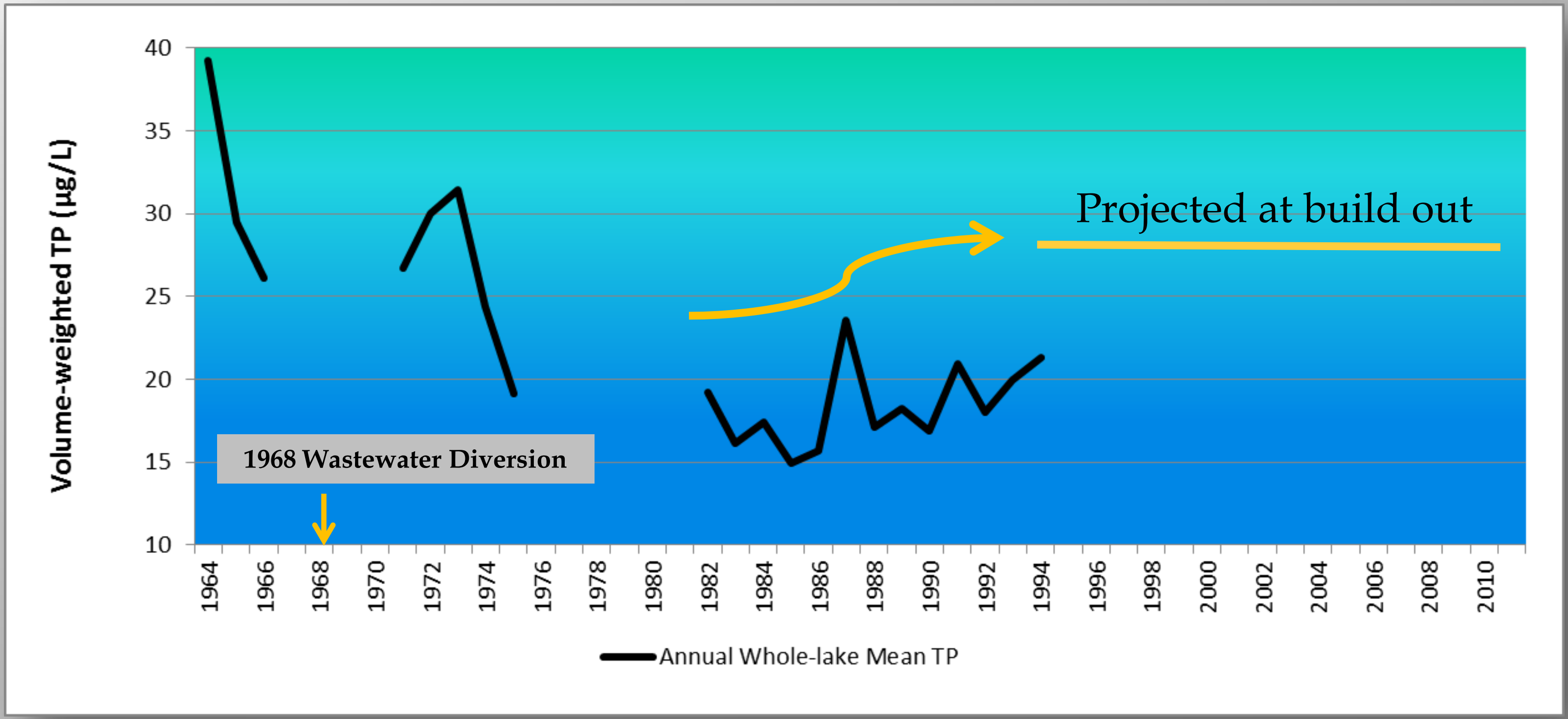


History of Lake Total Phosphorus

1968 - **Wastewater Diversion**
35% reduction in TP from an annual mean of 32 µg/L to 15-20 µg/L by the mid- 1980s

1990s - Observed a gradual increase in TP raised concerns about non-point pollution

1994 - **Model predicted annual mean TP of 28 µg/L** at full build out
with no management actions taken



History of Lake Total Phosphorus

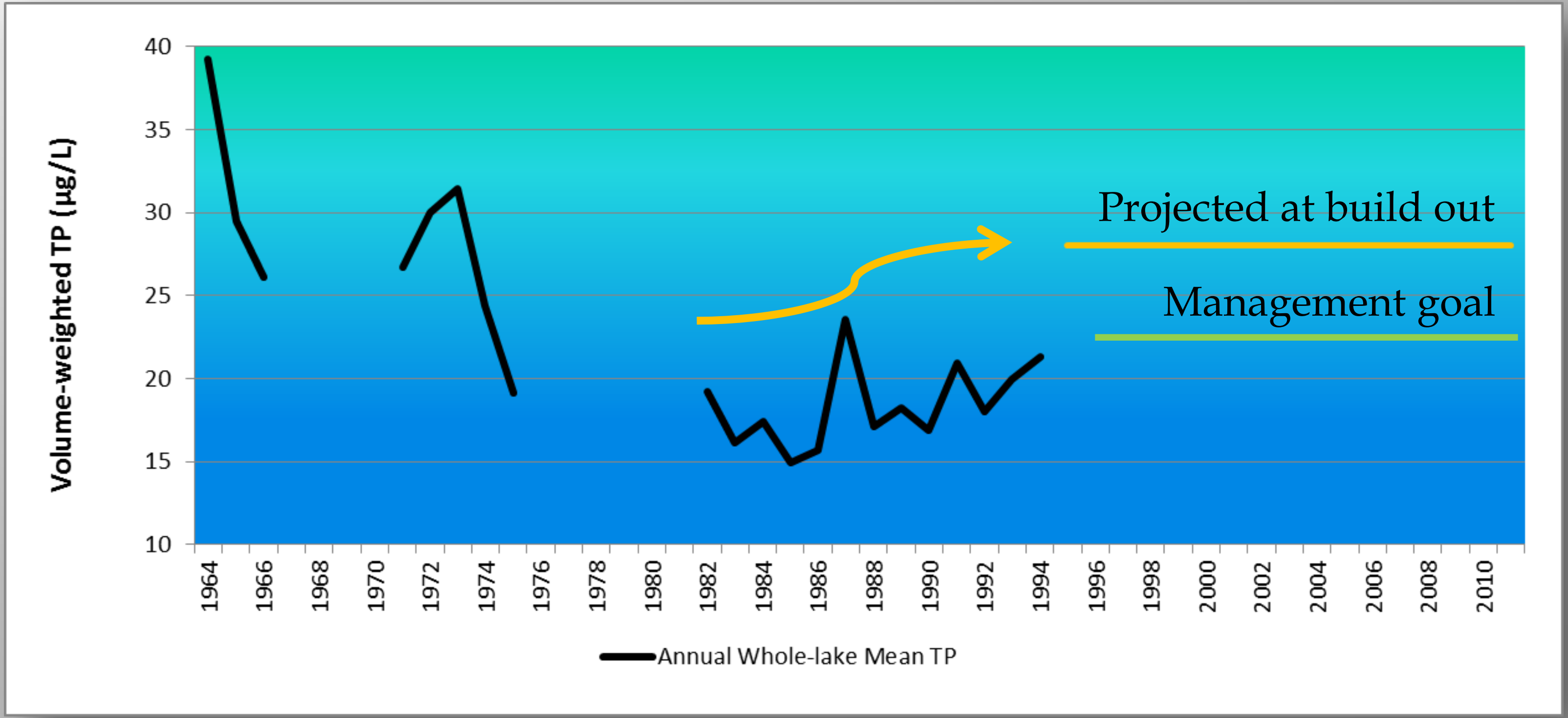
1995 - **Lake Sammamish Initiative**

An inter-jurisdictional and citizen task force effort to prevent water quality degradation.

Lake Management Plan - management goal of **22 µg/L TP**

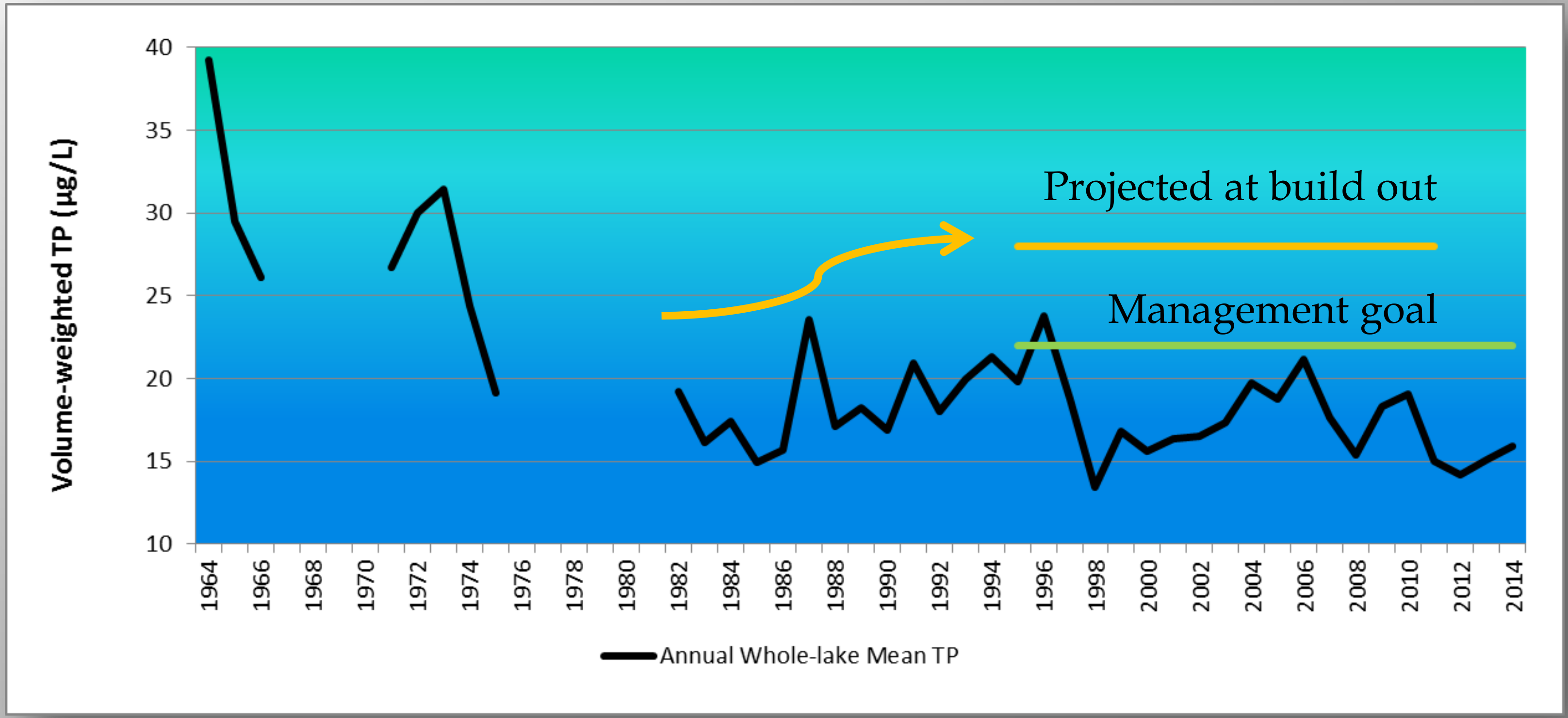
Recommended management actions:

- 50% stormwater TP retention in new development
- 65% forest retention in rural areas
- multiple short-term actions



Current Lake Total Phosphorus

- Annual whole lake TP has remained below goal of 22 ug/L
- No significant change in annual whole lake TP even with the increase of developed land.



Watershed Development

1994: Updated County Comp Plan – refined the Urban Growth Boundary

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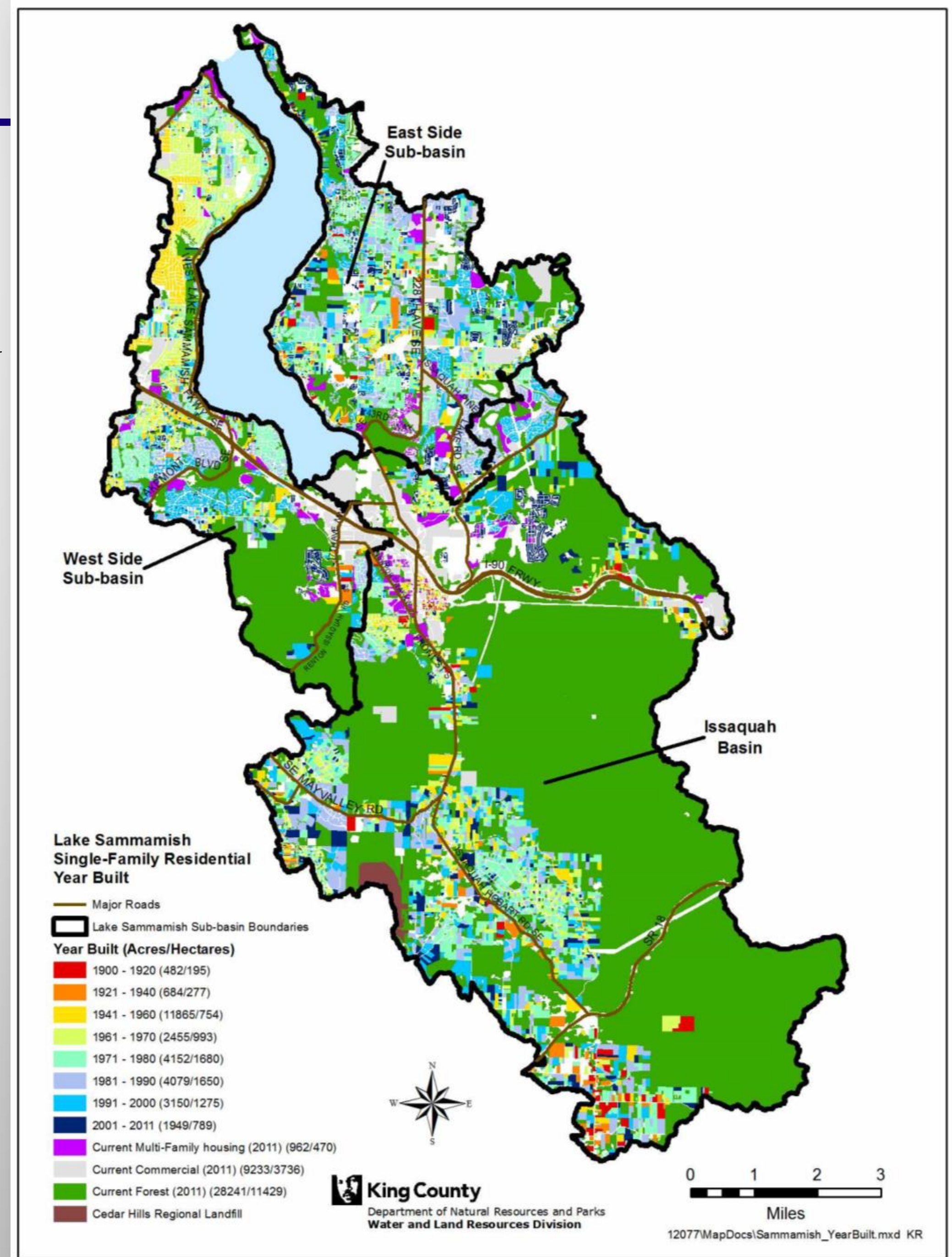
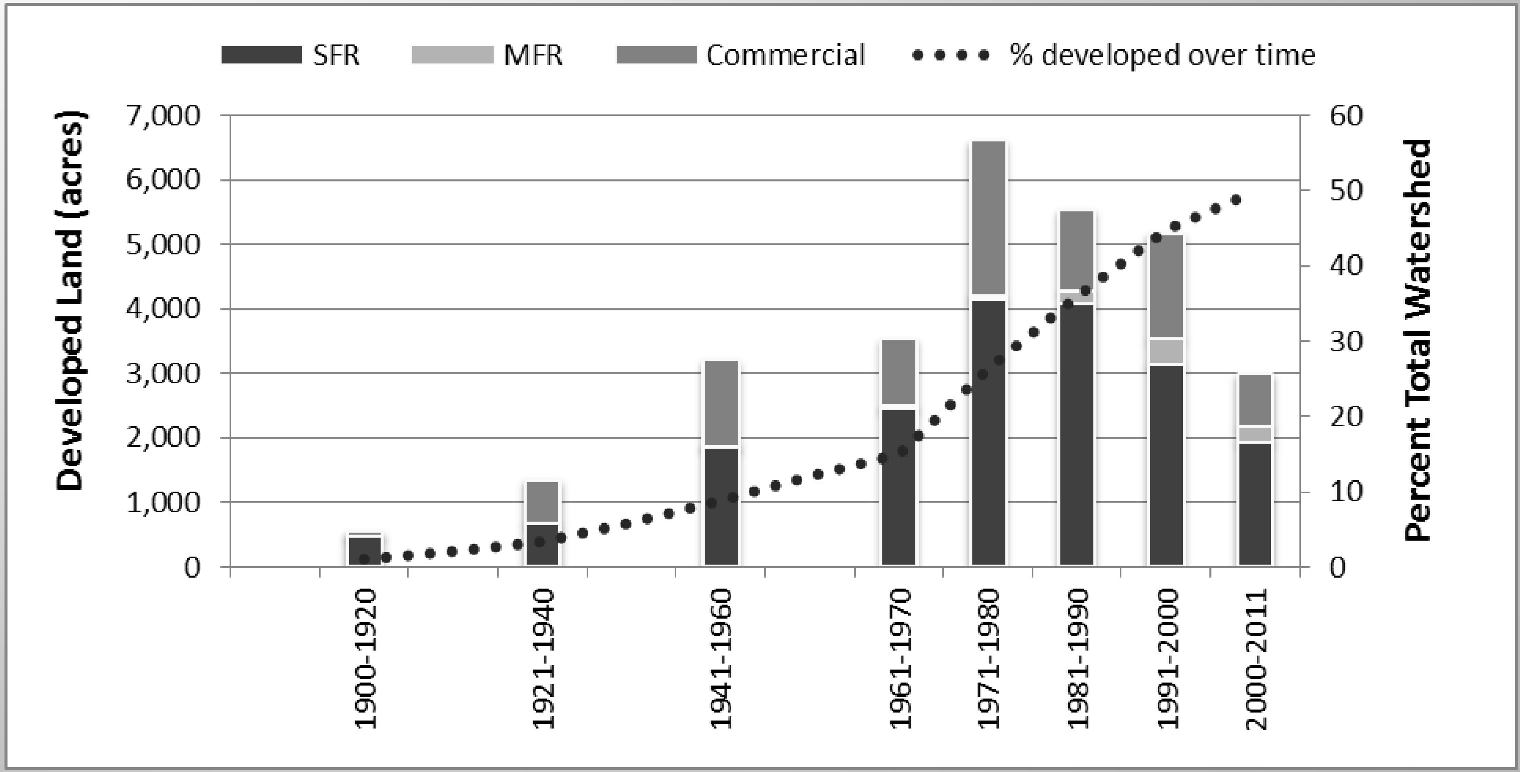


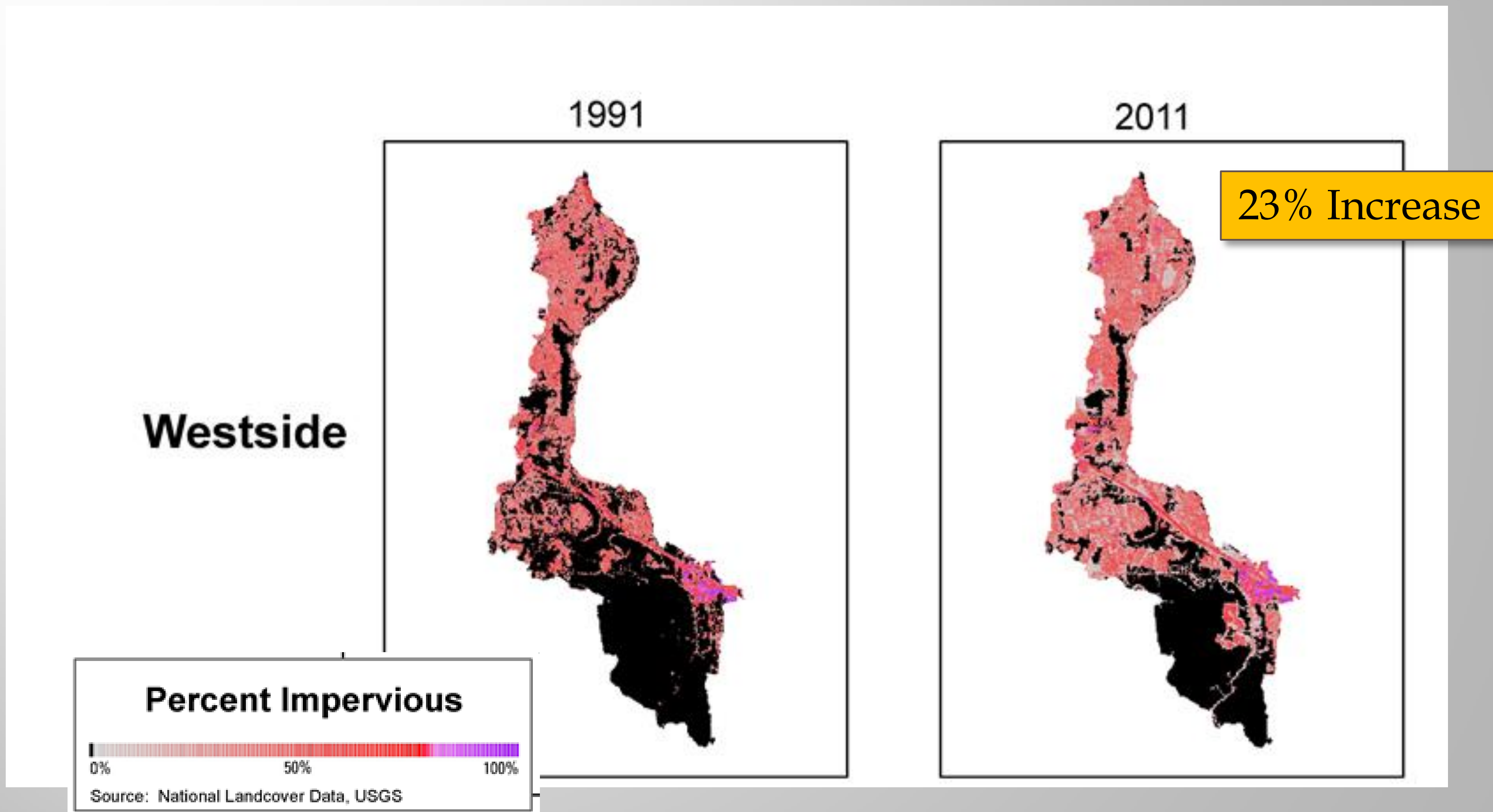
External Load - Watershed Development

- Land area developed has doubled since the 1970s, although the rate has declined as the east and west sides of the lake are essentially built out



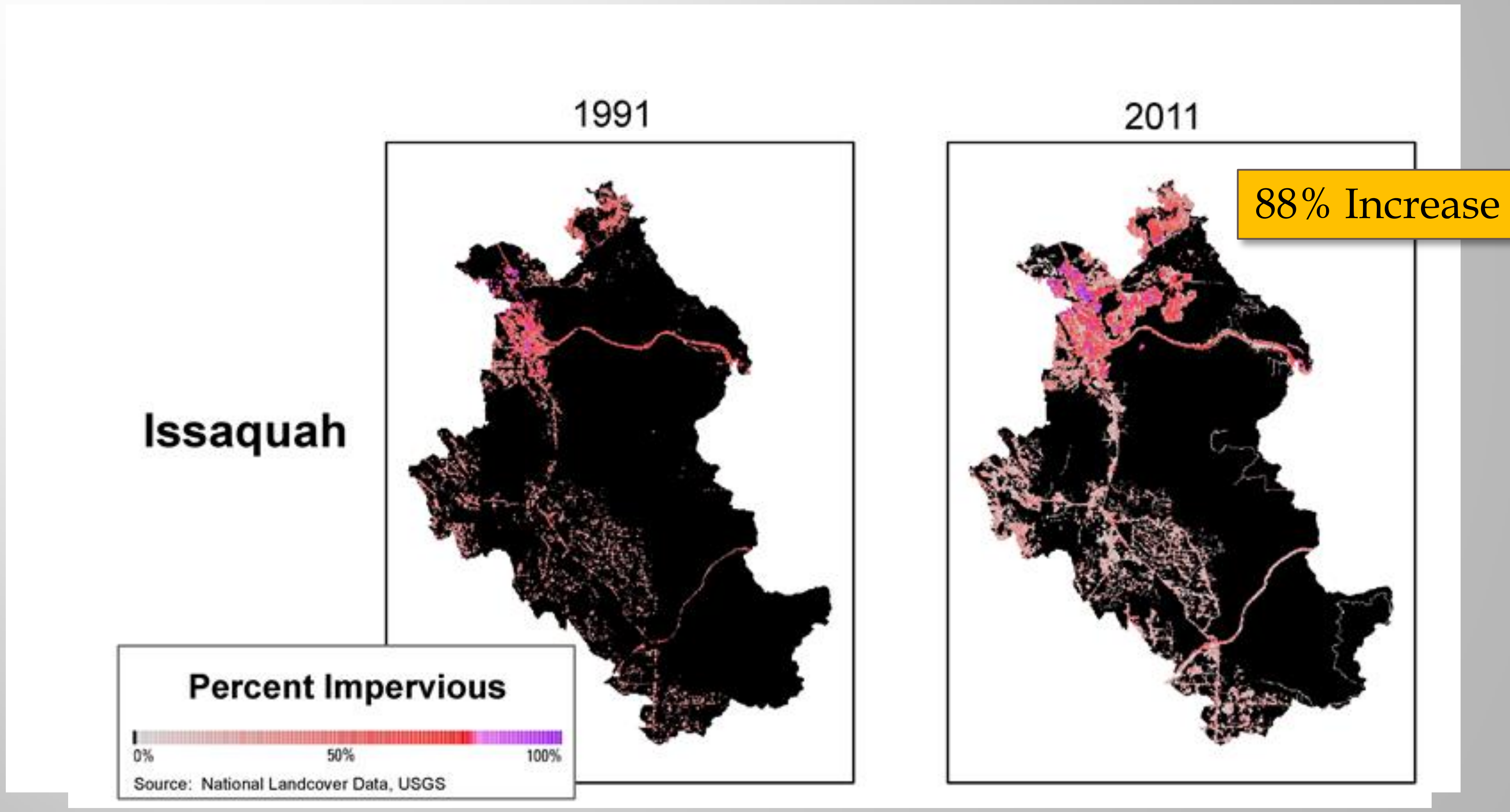
Based on total As Builts submitted for designated time period.

Impervious Area



Data from NOAA Coastal Change Analysis Program (C-CAP)

Impervious Area



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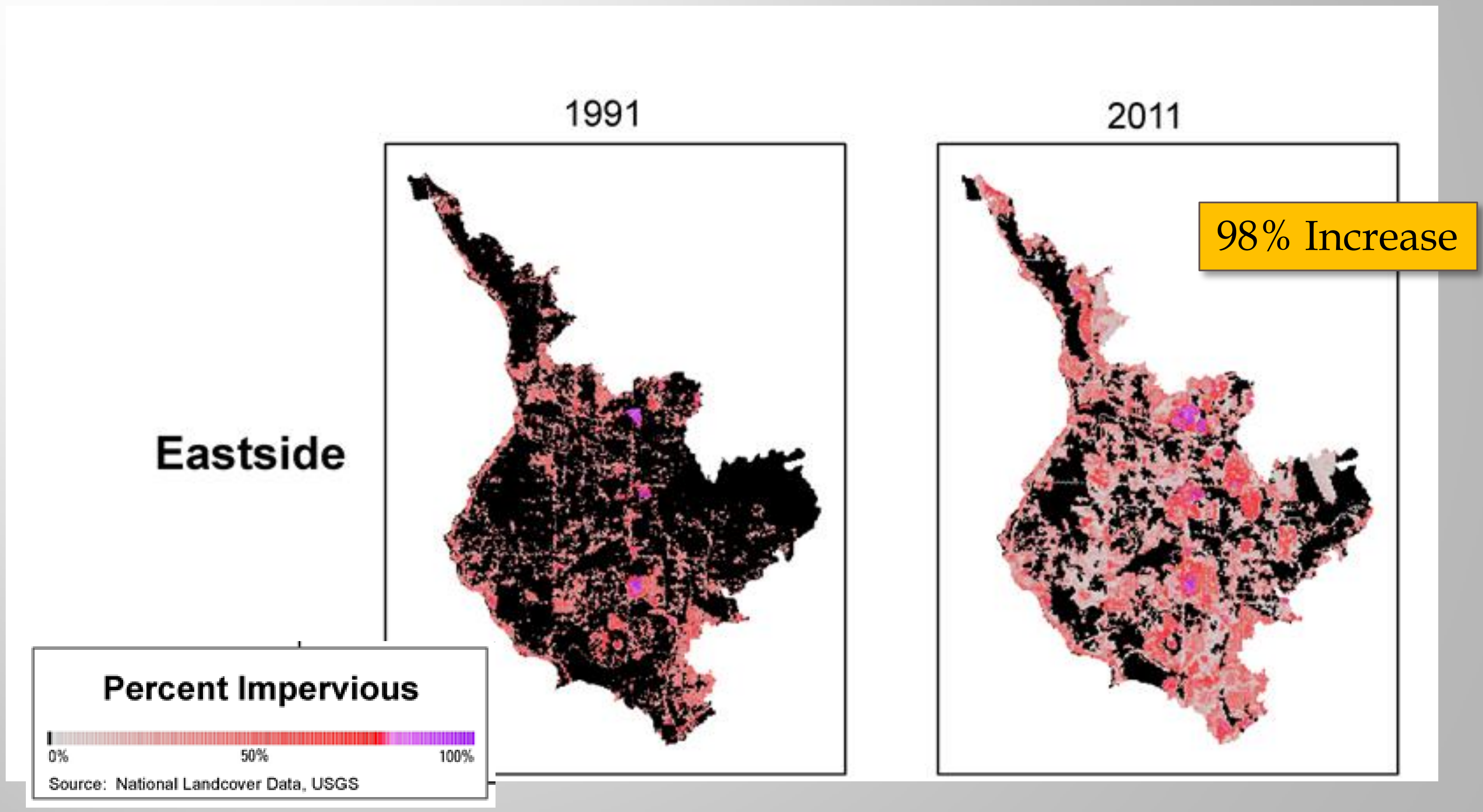

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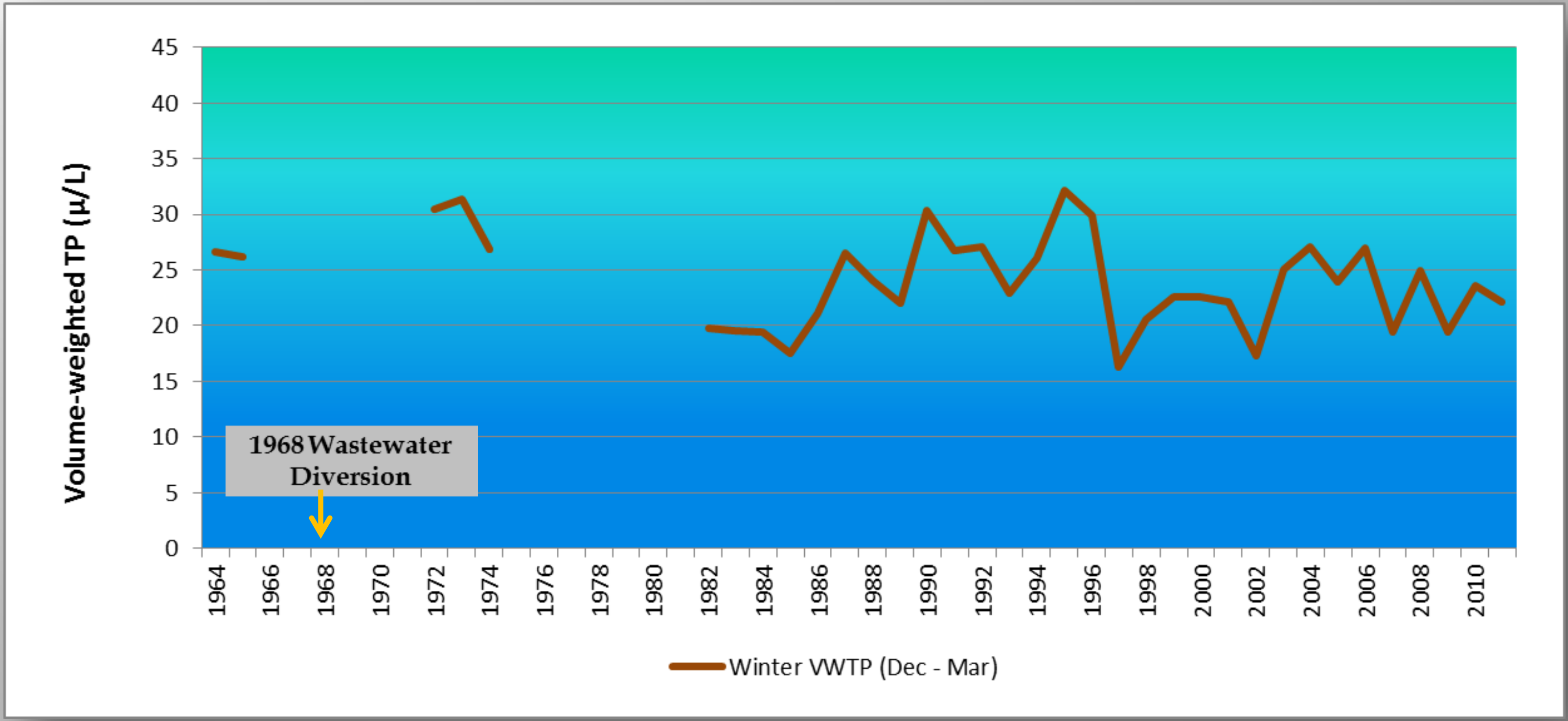
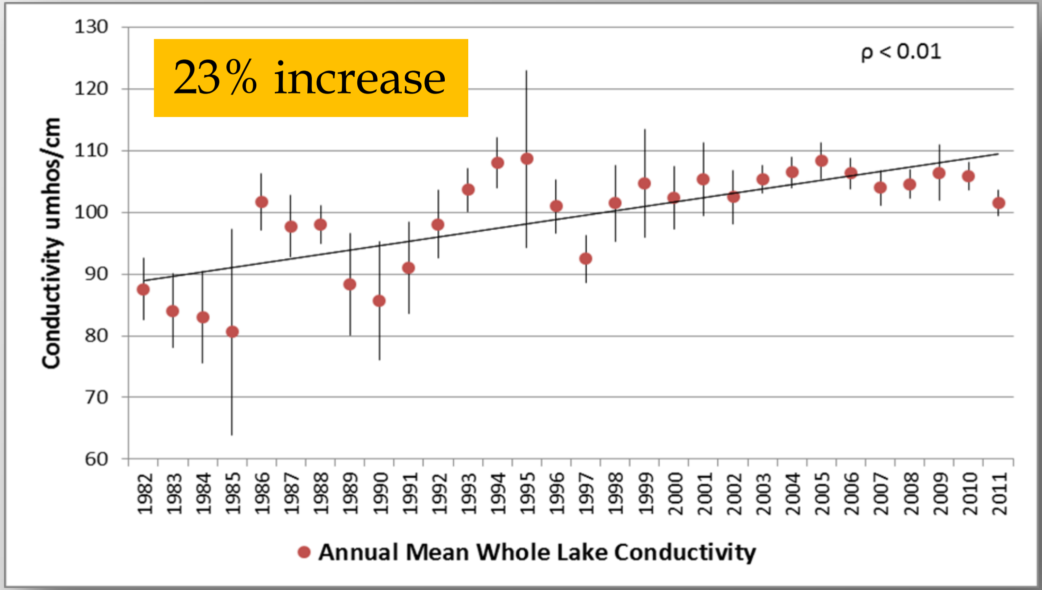
Winter Whole Lake TP

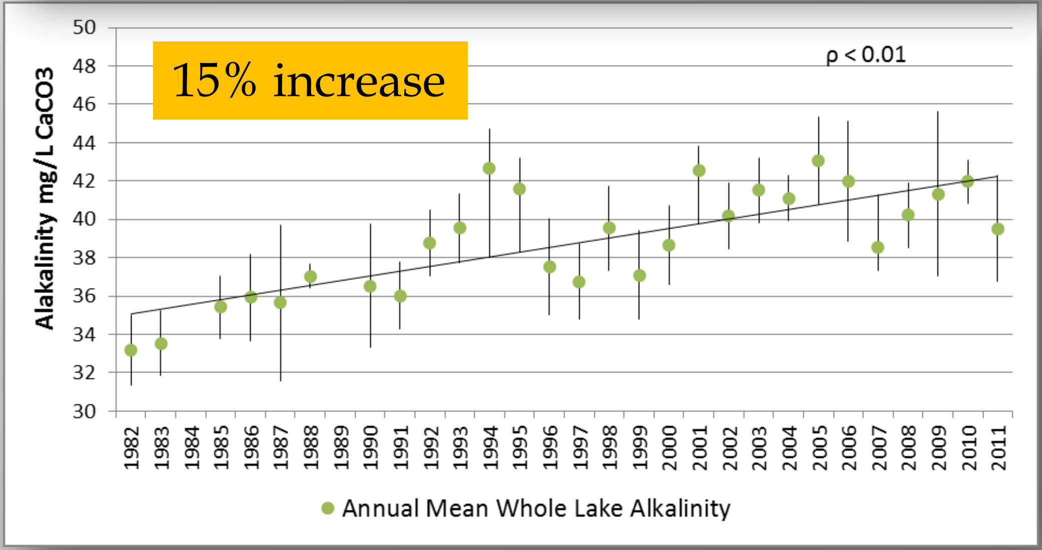
- Winter TP would be expected to increase with increased development and stormwater runoff, which is highest during winter in the PNW
- No significant trends in winter TP



Lake conductivity and alkalinity (± SD)

- 1982 to 2011 - both conductivity and alkalinity have significant increases
- Increases in these conservative substances typically associated with stormwater runoff.
- Increases due to less dilution from tributaries?

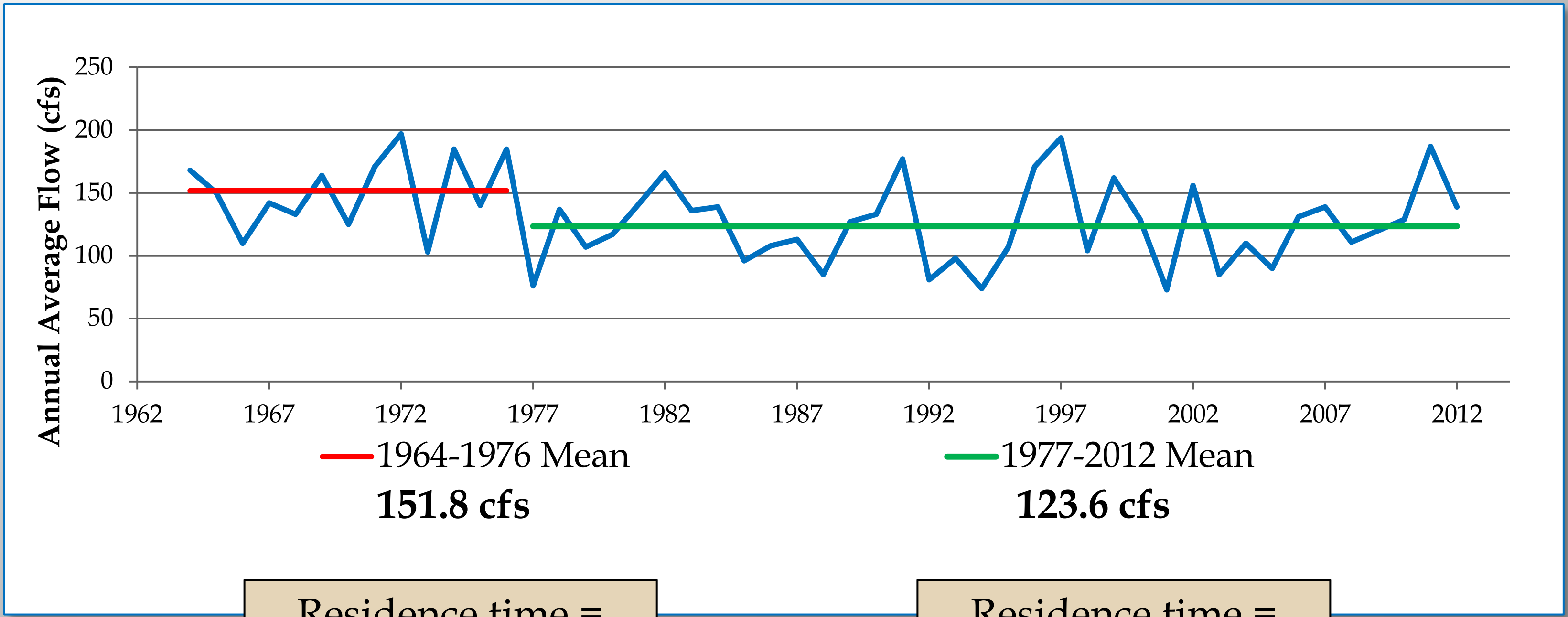




1980 and 1981 not included due to insufficient data.

Issaquah Creek Flows

- 70% of the total water flow into the lake
- No trends
- Horizontal lines represent mean flows for the two Pacific Decadal Oscillation periods: "wet/cool" during 1940s -1976, "warm/dry" during 1977-2012



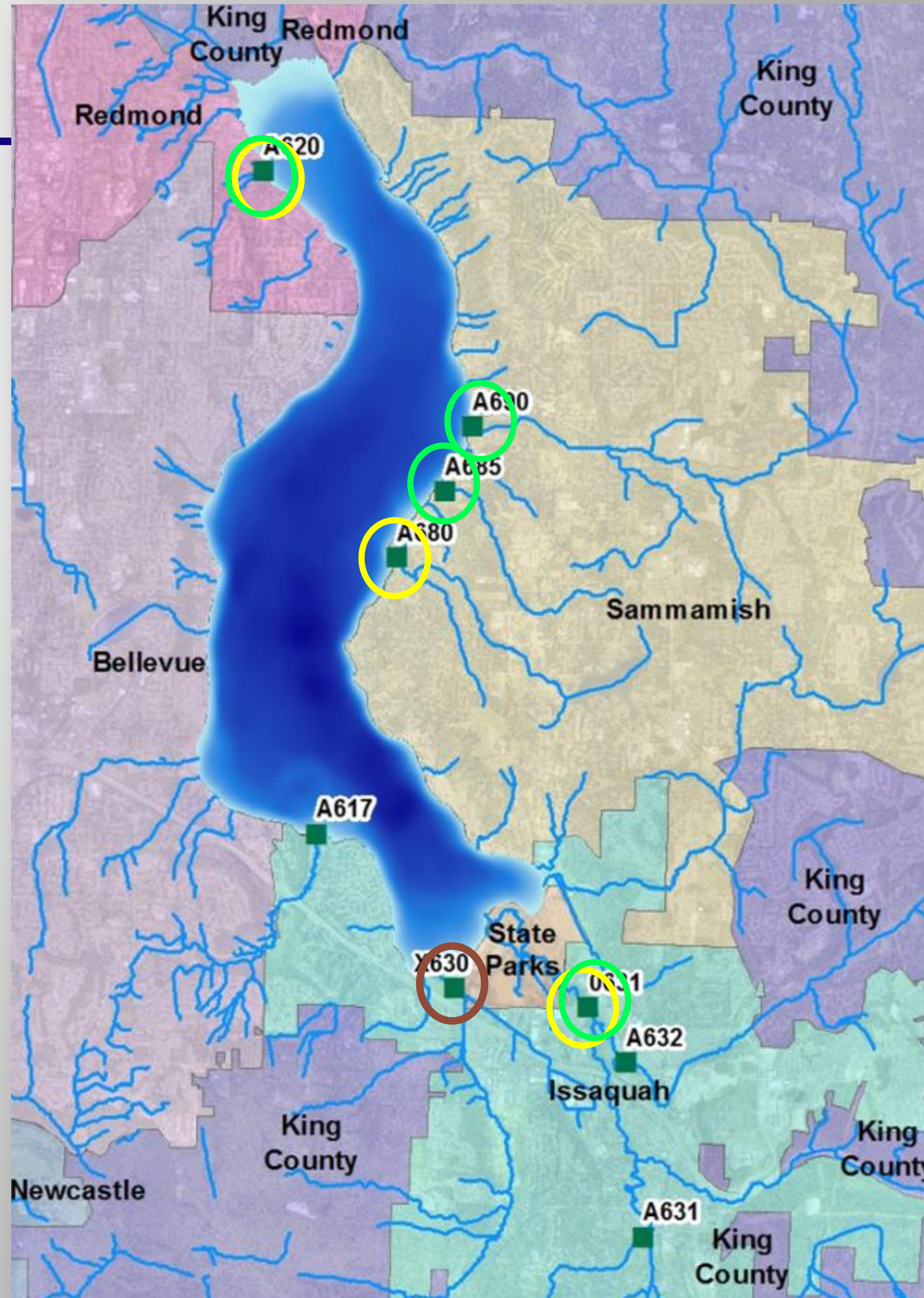
Residence time = 1.79 years

Residence time = 2.17 years

21% increase in residence time

Tributaries

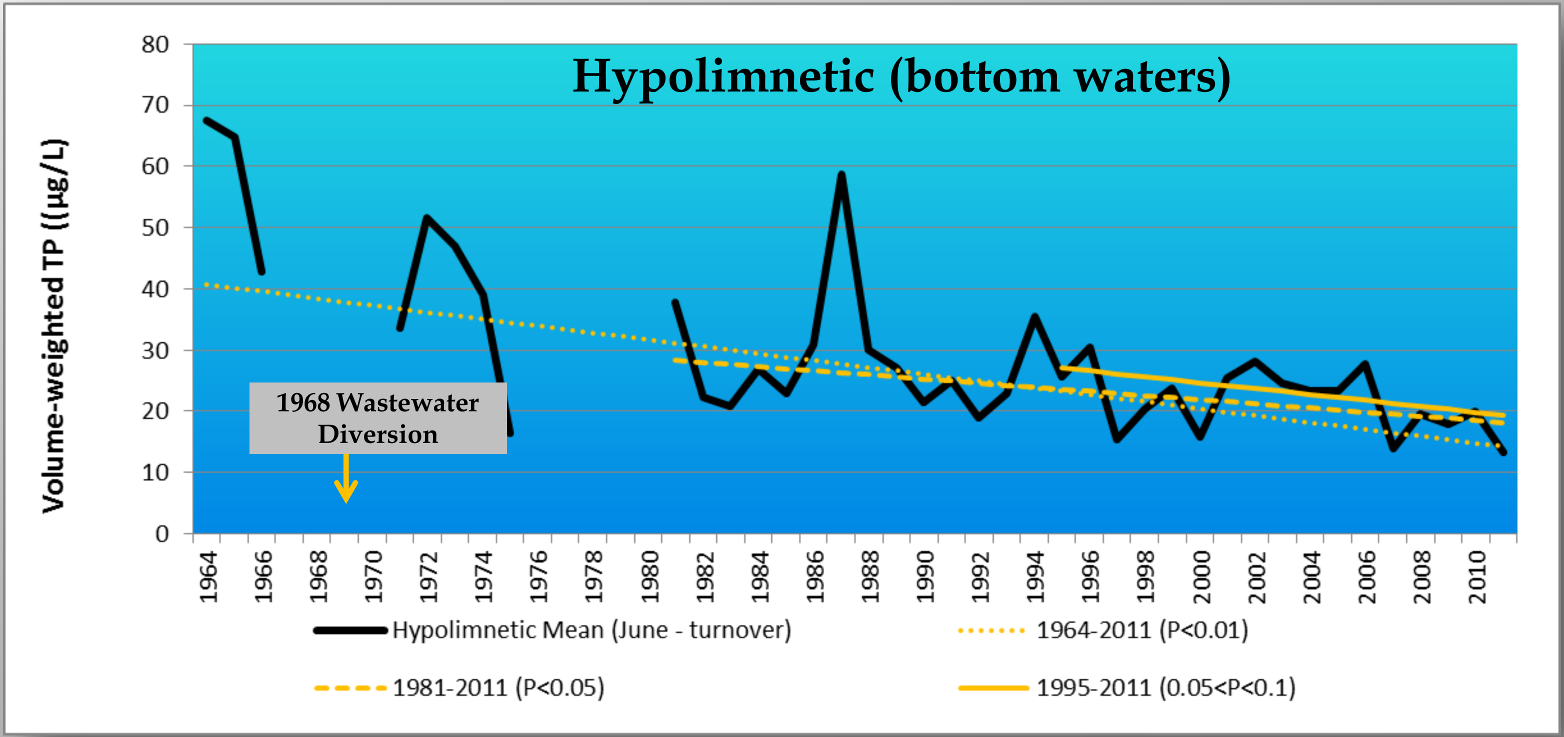
- Period of record varies – most 1995 to 2008
- TP – no significant change - except Tibbetts increased 1997 to 2008
- Soluble P – decreased significantly in Issaquah, Pine Lake, and Idlywood
- Conductivity – increased in Ebright, Eden and Idlywood. Slight increase in Issaquah



Internal Load - Summer TP

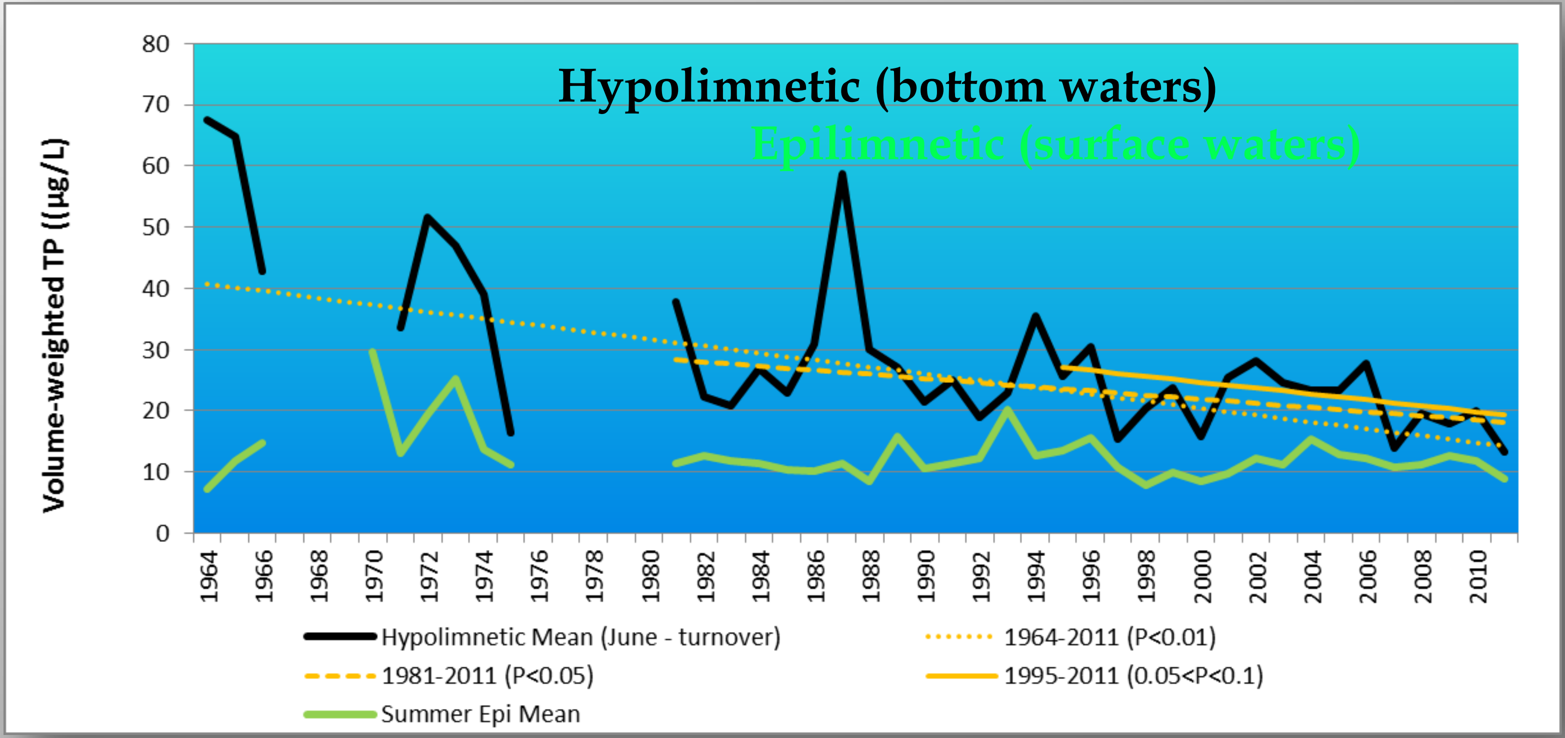
- Internal loading – sediment bound phosphorus released into the bottom of the water column during periods of low oxygen.

- Mean summer hypolimnetic TP declined significantly since the 1980s



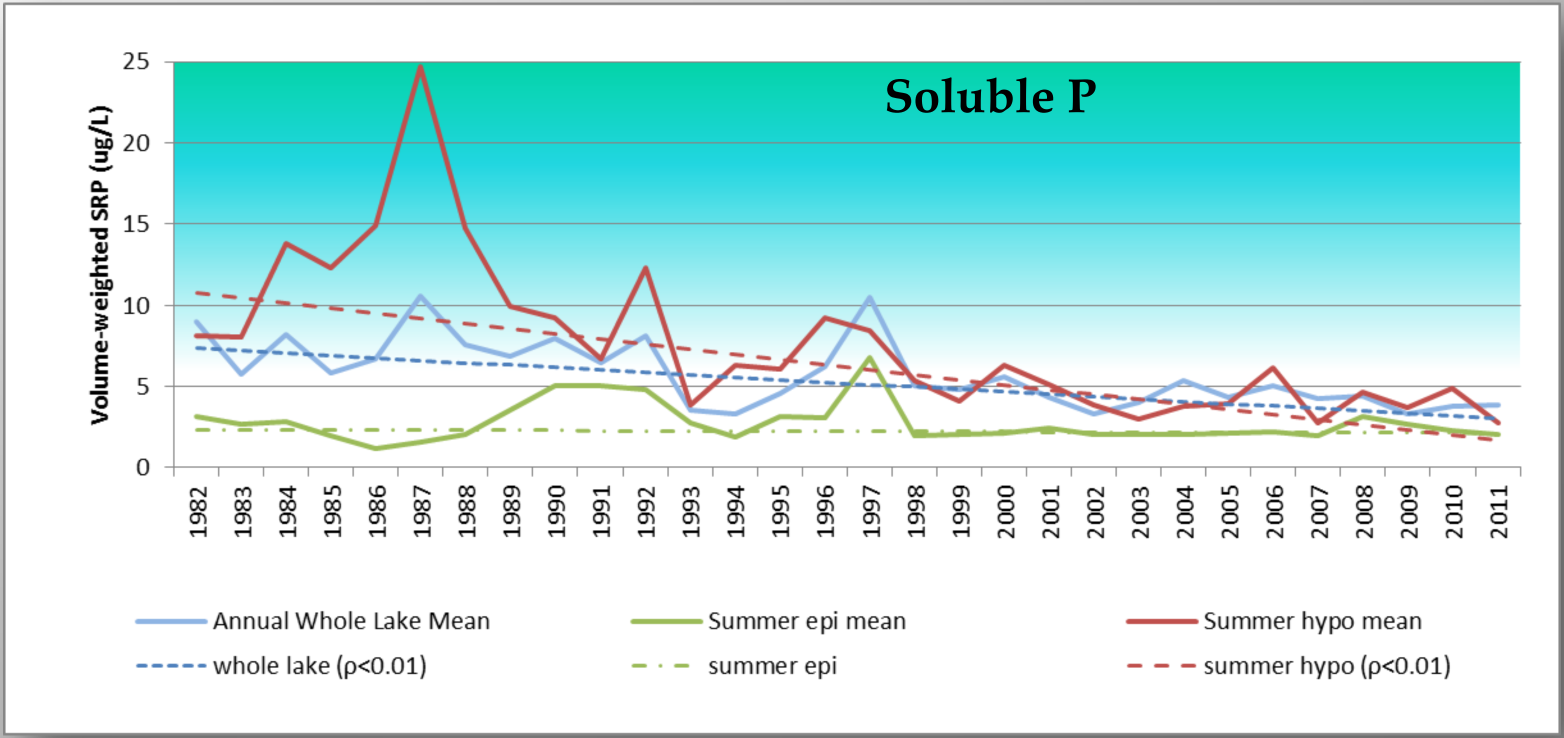
Internal Load - Summer TP

- Summer mean epilimnetic TP has been stable since the 1981 ranging from about 8-21 µg/L with a mean of 12 µg/L
- Subsequently, summer chl has remained stable at about 3 µg/L, while mean transparency has actually increased to over 5m



Internal Load – Soluble P

- Gradual, long-term decline in sediment phosphorus release (~ 80% since the 1960s)
- Mean hypolimnetic TP and Soluble P declined significantly since the 1970s

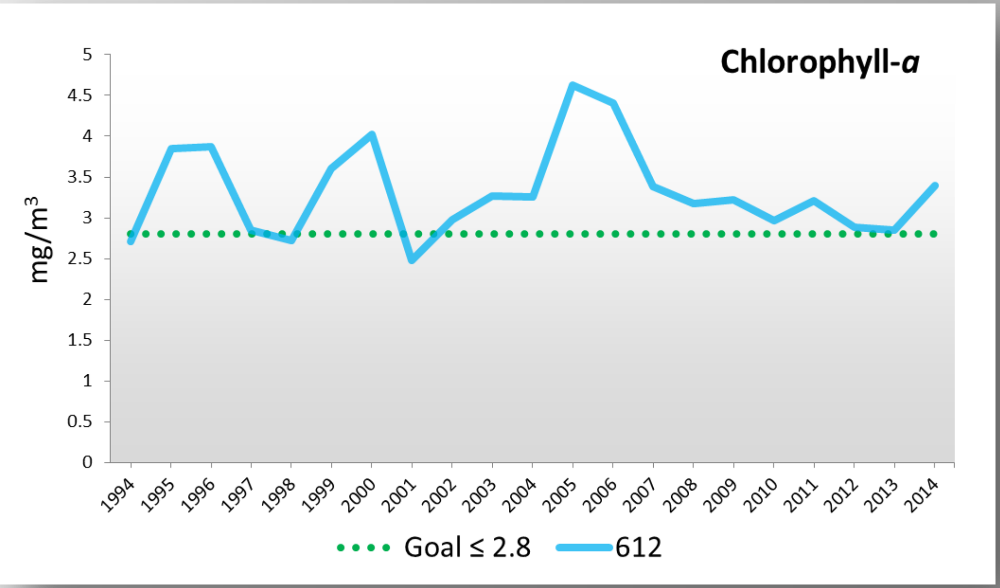


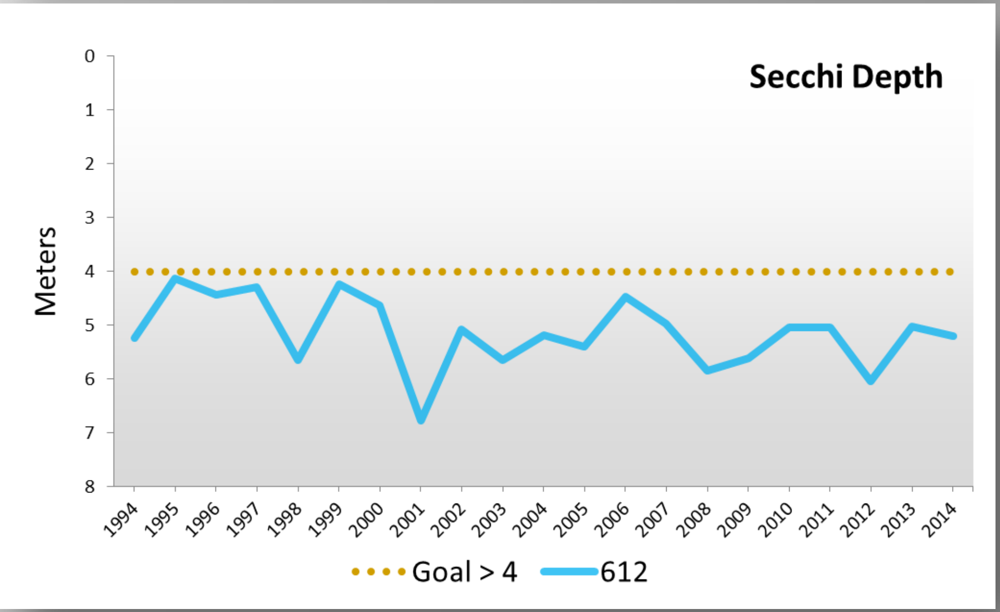
Management goals for Chl *a* and Secchi

Summer (June – September)

- **mean chl *a* ≤ 2.8 µg/L**

- **mean Secchi ≥ 4.0 meters**





Conclusions

Mean annual TP has remained relatively stable over the last 20 years despite increased development.

Probable causes:

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Probable causes:

1. Nearly 2/3 of the stability is explained by reduced hypolimnetic TP due to gradually declining sediment release rate of ~80% since wastewater diversion

2. Water residence time has been slightly longer (21%) since the 1970s – allowing more time for particulate matter to settle – and may account for some of the increased transparency, since chl has remained rather stable

3. Imposed stormwater controls since the mid 1990s requiring 50% TP removal in new development. As well as other basin planning efforts.

4. Forest retention in the upper Issaquah Creek watershed ~ 73% (e.g., Taylor Mountain Forest acquisition in 1997 – 1822 acres had been platted development.)

5. Other basin planning efforts in 1990s – Issaquah Creek Basin Plan, East Lake Sammamish Basin Plan, County Comprehensive Plan.

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Acknowledgements

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  Save Lake Sammamish


Questions
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http://i.imgur.com/Eot6v21.jp